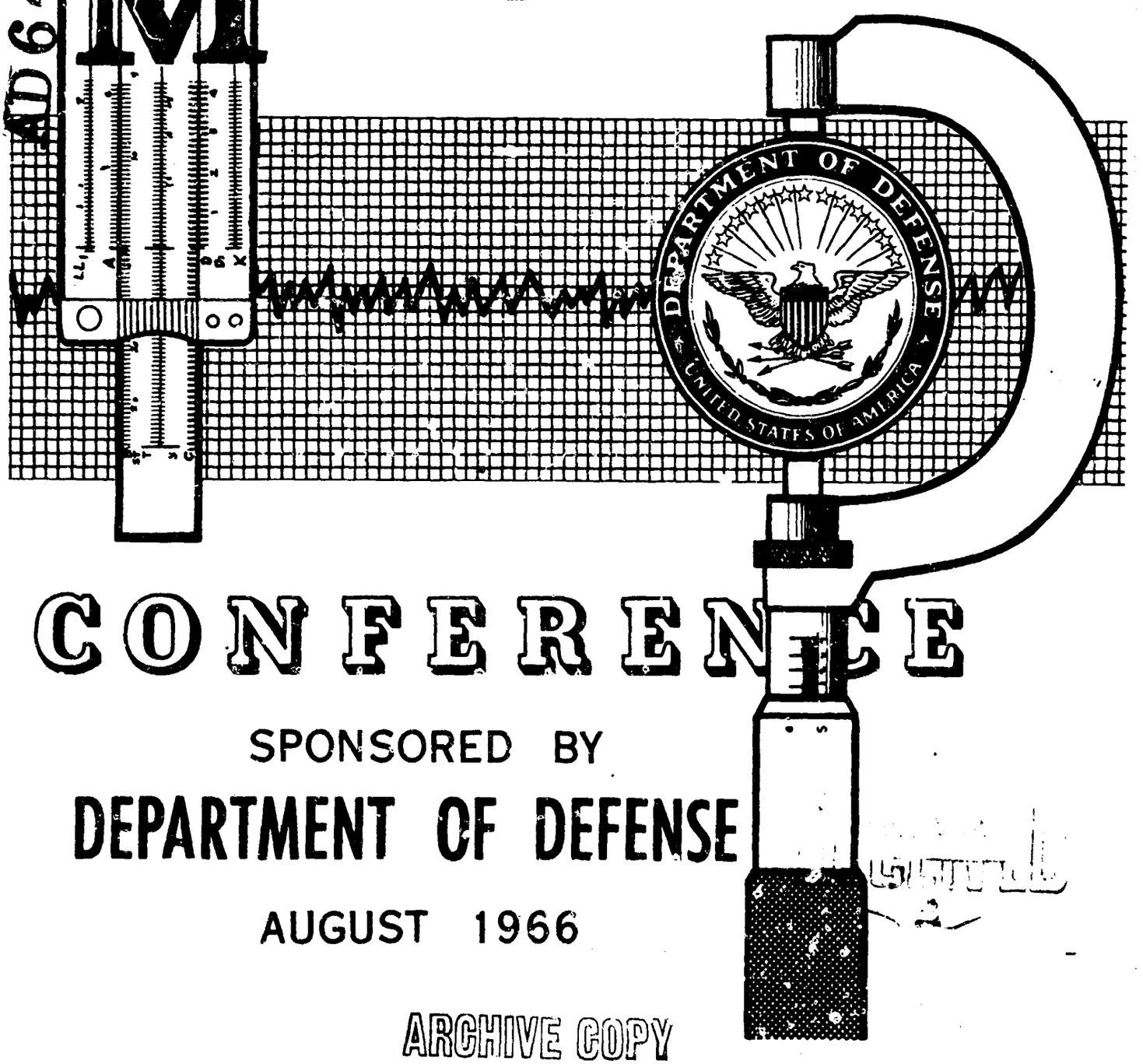
VOLUME 1

Quality and Reliability Management



CONFERENCE

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DEPARTMENT OF DEFENSE

AUGUST 1966

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Honorable Finn J. Larsen, Deputy Director, Defense Research and Engineering

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PROCEEDINGS

DEFENSE CONFERENCE ON

QUALITY AND RELIABILITY MANAGEMENT

2, 3, and 4 August 1966

United States Naval Academy

Annapolis, Maryland

VOLUME I

DEPARTMENT OF DEFENSE
Washington, D. C.

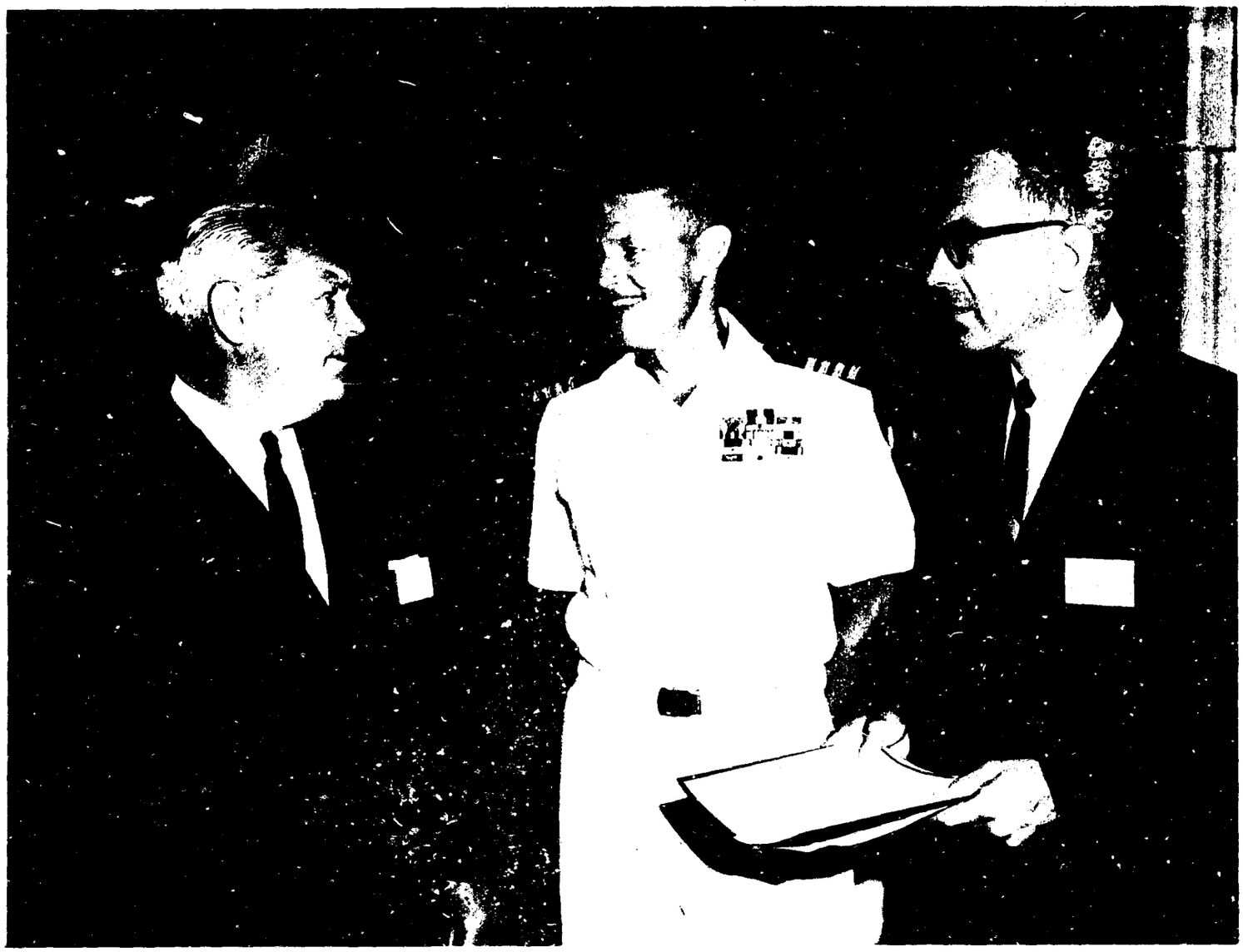
OBJECTIVES OF THE CONFERENCE

1. Analyze the principal quality and reliability problems that confront the Department of Defense.

2. Assess pertinent current efforts and proposed plans which are aimed at solving these problems.

3. Exchange ideas on solutions of these problems.

4. Recommend to executive levels of the Office of the Secretary of Defense, the military departments and the Defense Supply Agency: (a) appropriate and immediate actions to resolve specific quality and reliability problems, and (b) long-range plans and programs for improving quality and reliability assurance efforts.



Deputy Assistant Secretary of Defense (Installations and Logistics) for Equipment Maintenance and Readiness George E. Fouch (Left) and Acting Superintendent U. S. Naval Academy Captain Sheldon H. Kinney (Center) with Conference Director Horace R. Lowers

ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

INSTALLATIONS AND LOGISTICS

MEMORANDUM FOR THE CONFEREES

Welcome to the first Defense Conference on Quality and Reliability Management. We are confident that this conference will bring into focus the major problems that confront all components of the Department of Defense in their efforts to improve quality and reliability assurance. The purpose of this conference is to provide a forum for interchange of ideas among knowledgeable personnel of the Services and the Defense Supply Agency which, hopefully, will lead toward the solution of many of these problems.

The increasing complexity of our military materiel has caused a corresponding complexity in the tasks associated with the prediction, achievement, maintenance, and assessment of the necessary quality and reliability. As the costs of materiel have increased, so have the costs of quality and reliability assurance. Improved management of quality and reliability will contribute significantly toward advancing our technology, decreasing acquisition lead time, conserving technical resources and improving logistical support of our weapon systems and equipment. Better management in all of these areas will also result in considerable cost benefits on behalf of industry and Government.

It is both essential and timely that we examine our policies, procedures and techniques in order to improve our quality and reliability assurance efforts throughout the Defense community. You have been carefully selected as Conference participants in recognition of your ability to contribute toward this end. We are expectant, therefore, that the first Defense Conference on Quality and Reliability Management will prove to be highly productive. We look forward with great interest to the results of your efforts.

Paul R. Ignatius

PAUL R. IGNATIUS
Assistant Secretary of Defense
(Installations and Logistics)

Finn Larsen

FINN J. LARSEN
Deputy Director, Defense
Research and Engineering

Deputy Director of Defense Research and Engineering Finn J. Larsen (Left) and Conference Steering Committee Chairman John J. Riordan

FOREWORD

These Proceedings are a record of the First Department of Defense Conference on Quality and Reliability Management. The Conference brought together more than 130 participants from Department of Defense activities, National Aeronautics and Space Administration, Federal Aviation Agency, General Services Administration, and National Bureau of Standards. More than 100 guests were present from the Atomic Energy Commission, Food and Drug Administration, National Security Agency, and Logistics Management Institute in addition to those from the participating activities.

Attainment of the objectives of the Conference was based on the pre-conference and conference activities of nine panels or working groups, which examined in depth, specific aspects of the management of the military quality and reliability programs. The panels considered problems concerned with quality and reliability management during the development of operational requirements, materiel development and production, and storage and maintenance during the use phases. The conferees also discussed the problems associated with the calibration of equipment and the quality of software to support materiel acquisition and use.

It is anticipated that these Proceedings will serve not only as a cross-sectional record of Department of Defense quality and reliability management thinking as of August 1966, but more importantly as a tool to help shape the action of quality and reliability improvement programs of the future. To this end, 166 recommendations for action resulted from the panel deliberations. The principal recommendations were presented orally, by the panel chairmen, to the Department of Defense Quality and Reliability Assurance Council and other high ranking representatives of the Department of Defense on 4 August 1966.

The Proceedings have been prepared in two volumes. Volume I contains the keynote addresses and summaries of the panel reports; Volume II contains full panel reports.

Horace R. Lowers

HORACE R. LOWERS
Conference Director

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CONFERENCE PANELS

Two of the Conference's Nine Working Panels in Session

REPORT OF PANEL 1

TITLE: Quality and Reliability Management Concepts

OBJECTIVE:

To determine those objectives, concepts, policies and uniform procedures essential to effective quality and reliability management within the Department of Defense.

TOPICS DISCUSSED:

1. The Problem and Its Environment
2. Policy
3. Communication
4. Organization
5. Resources
6. Discipline
7. Integrated Engineering
8. Incentive

GENERAL BACKGROUND:

THE PROBLEM AND ITS ENVIRONMENT

The quality of today's products in use within the Department of Defense is generally good. This is borne out by use throughout the world, including Vietnam. The occasional failure which does occur is usually remedied without serious consequence. Nonetheless, further development, integration and better utilization of the quality, quality assurance, reliability, reliability assurance, maintainability (QARAM)[1] disciplines might lessen the admittedly high cost of reasonably high quality, or provide improved quality at little additional cost. There is no adequate basis for quantitative comparisons. Intensive system analysis directed specifically to this end is required to quantitatively evaluate these potentials.

Technology is moving far more rapidly today than ever before. It has made likely the situation that a product can be obsolete before it comes off the production line if old methods of in-series production are used, i.e., conception, research and development, engineering, pilot plant operation, prototype, testing, production. Today's environment is a telescoping of these life cycle phases into a group of semi-parallel operations in which each succeeding life cycle phase is started well before the preceding one is completed. Under such circumstances, it appears mandatory that there be maximum use of the QARAM disciplines to insure that the product does do its job despite the telescoping and other program constraints.

Problem understanding has been considerably hampered by poor definitions of the basic terminology in use; for example, definitions of quality, reliability and maintainability. Many such definitions currently exist. Since many definitions exist, many interpretations exist. Further, the communication of the QARAM ideas has been ineffective due to large amounts of communication which are duplicative in many areas but leave substantial gaps in others. Finally, there are many factors, each having an extremely broad spectrum of variation to be considered in formulating an integrated approach to the QARAM problem. One such factor is product complexity, in which the spectrum ranges from nuts and bolts, and shoelaces, through trucks, tanks, aircraft, and high performance submarines to even more complex systems. Other factors of concern are the design life of the product, the production

[1] The use of QARAM in this report is only for the purpose of expediency.

quantity, and the reliability requirement (based on product failure consequences).

POLICY

Despite a fairly large number of OSD policy directives on the street supplemented by subordinate headquarters directives, there exist substantial gaps as well as overlaps in policy directives. It appears, therefore, that the policy statements of the Office Secretary of Defense require revision and condensation.

The organizational and product role of QARAM must be properly defined. There must be full identification and auditability of the QARAM role. This QARAM role prior to production of the product is one of "think" and establishment of realistic product attributes; in subsequent phases of the life cycle, it is a "do" function concerned essentially with the disciplines of measurement, enforcement, monitoring, and feedback.

The government's role in the spectra of product life, product complexity and product delivery date must be defined more clearly, as must be the vendor's role. There needs to be in the policy statement, a requirement for a disciplined plan of action, which includes integrated engineering as one of its basic concepts. Industrial funding operations of the government activities should be provided as a basic costing element in conjunction with the relaxation of conflicting administrative constraints. Finally, incentive motivation should be high in the requirements for each policy directive emanating from the Office Secretary of Defense.

COMMUNICATION

Policy dissemination for problem resolution has not been satisfactory because the definitions of quality, quality assurance, reliability, reliability assurance and maintainability have been inconsistent and the proliferation thereof has resulted in misinterpretation and misunderstanding. It would be well to examine these essential elements and require that standard definitions be established and used throughout the Department of Defense. There is also need to examine the QARAM directives, which are currently outstanding. We reviewed more than 150 such directives involving many thousands of pages of directive material. When these are added to the various additional requirements of specifications, it becomes quite clear that compliance is very difficult, if not impossible, for field activities and contractors. Condensing and collating appear to be a very profitable field for improving communications.

There needs also to be an information gathering system which could be either centralized as in the Defense Documentation Center concept or decentralized in various activities using a common access approach through common forms or through interpreting computer connections. This information gathering operation should include information on vendor capability, vendor performance, product quality, product reliability, product maintainability and on the resources of the various government activities, particularly in the field of QARAM.

ORGANIZATION

Since the problem is so broad and the spectra so diverse, it is unlikely that a single organizational structure, position or element for the QARAM technique would provide a satisfactory solution. What is required, however, is full QARAM identification and auditability in each organization and in each product life cycle to insure that this important element is properly provided. QARAM should be placed organizationally to assure authority and management access commensurate with other functional disciplines. There is a need to integrate the splinter disciplines, which have tended to become overemphasized and to distort current products. These disciplines, including standardization engineering, human engineering, safety engineering, etc., should be restored to the basic integrated engineering structure, both in the Department of Defense and the various vendors' operations to insure maximum effectiveness.

Within the Office Secretary of Defense, the organizations of the Defense Director for Research and Engineering, and Assistant Secretary for Installations and Logistics appear adequate to handle the QARAM philosophy. It is understood that the basic QARAM "think" capability, that is, determination of quality of the product through product attributes (considering quality, reliability and maintainability as product attributes) is a function of engineering and that the basic QARAM "do" function, which is enforcement, is a basic Installations and Logistics responsibility; (that is the primary monitoring and enforcement of the attributes called out by engineering).

In all organizational matters, the audit function must be fully represented, fully available and used. Every organization involved requires such capability. It should be provided.

RESOURCES

Within the next five years there will be a serious reduction in this capability due to the age of many of the personnel involved in the

QARAM operations in the field. This falling off of World War II and Korean War personnel requires replacement by other personnel resources. There is a need for an acquisition plan which includes the necessary training and cross-fertilization of personnel so that they can be completely effective. Further, there is a need for a retention of personnel plan which would provide for the requisite career patterns to insure that personnel currently on board or acquired remain with the government. (This is to be covered by Panel 7.) Finally, there is a need to consider the manner in which the personnel resources are utilized under current types of products. There is duplication of effort among government activities and among the various vendors and sub-vendors. Such duplication of effort is undesirable, is unnecessarily costly, time-consuming and results in confusion. There is a need to develop plans to prevent such undesirable duplication.

DISCIPLINE

The success of the Office Secretary of Defense plan for QARAM resides not only in having a good plan, but also in those additional elements which we collectively call the "discipline" discipline. The fifth definition in the American Collegiate Dictionary is "A state of order maintained by training and control." We are considering such a situation in this concept. The maintenance of a state of order indicates that there was a concept, a development of a plan, a mode for implementation, a promulgation, an execution, and auditing and finally an improvement of the plan, and that these acts were performed by personnel of requisite skills, background, training and desire. Thus, the "discipline" discipline involves the total operation of thinking and doing.

While QARAM has no specific plan because of the immense complexity of the Department of Defense spectra of products, life cycle products and product age, personnel available, facilities and equipments available, it is necessary that the concept of discipline be re-emphasized in operations. The problem is sufficiently important for a basic conceptual plan to be developed, promulgated, executed and audited for the execution of the Office Secretary of Defense concepts for product management.

INTEGRATED ENGINEERING

The "think" phase of product development is all too often considered to include only the conception and design of the product. However, the "think" phase for full product exploitation must cover the entire life cycle. "Think" and engineering are reasonably synonymous in product development. Engineering is an inclusive term which, in essence, provides for professional personnel to apply their talents in a disciplined way to a specific aspect of a product's attributes or life. Basic engineering should think out the entire life cycle of the product. Because of the nature of the OSD, there is no requirement for large numbers of engineers operating in a basic engineering environment to develop a product or a series of products. Due to the use of various secondary disciplines or management disciplines, there has been acquired within the Office Secretary of Defense a number of splintered discipline capabilities, for example, safety engineering, value engineering, standardization engineering, standards engineering, etc. The proliferation of these splintered engineering disciplines has unfortunately sometimes resulted in undue emphasis being placed on certain aspects of product capabilities or product attributes. The emphasis results in distortion of the product in many cases, improper application of resources to the product. There is a great need to restore these splintered engineering disciplines to a basic integrated engineering framework. While it is not possible within the Office Secretary of Defense, such is possible within most of its field units. Unfortunately, by directives from the Office Secretary of Defense, splintered engineering disciplines in field activities usually are organized outside the basic engineering operations. As such, they cannot contribute effectively, and often tend to distort rather than to make effective. The "think" portion of the QARAM discipline, among others, needs to be included in the basic engineering effort for optimizing the products attributes for the product's entire life cycle. These attributes do, of course, include quality, reliability and maintainability.

INCENTIVE

In a situation as complex as that in which the Office Secretary of Defense operates, there can be no single management discipline, no single engineering discipline, and really no combination of these which provides basic policy which would be successful in all situations. The Office Secretary of Defense and other controllers of large complex efforts must go to the basic motivational disciplines which affect men. One such is incentive; incentive brings out the best in man. It is a

continuing type of motivation. Department of Defense directives, policies and efforts to acquire maximum effectiveness in the QARAM field (as well as in all others) should be by means of maximum use of incentive. This is desirable not only for the vendors of products desired by the Department of Defense but also for its own personnel in field activities, headquarters, and in the Office Secretary of Defense itself. A full range of incentive motivational devices should be explored, studied, developed and implemented. The use of an incentive approach could provide more benefit than all of the preceding efforts to describe and acquire a better system.

SUMMARY OF RECOMMENDATIONS:

Panel 1 recommends that:

1. The Office Secretary of Defense establish and chair a committee composed of representatives from the Department of Defense complex to set forth the format for a handbook utilizing the Quality Assurance, Reliability Assurance and Maintainability (QARAM) discipline. The handbook should be prepared by a qualified management source under the general guidance of this committee with a target date of 1 July 1967 for completion. It should include policy, general procedures, management concepts and techniques, and an appendix listing of all directives and implementing instructions in the QARAM field.

2. Department of Defense Directive 4155.11 be revised to cover the QARAM discipline with emphasis on identification and auditability of the product and organizational resources. Revision should include incentive, brevity, communication, contractor performance evaluation (CPE), unsatisfactory material reporting (UMR), and language. This effort should include the review of all listed Department of Defense directives for conformance with QARAM or elimination.

3. A directive be issued to support the QARAM discipline in the area of Office Secretary of Defense (DDR&E) jointly with Office Secretary of Defense (I&L) reaffirming that the determination of product is the function of DDR&E and the fulfillment of the QARAM requirements if the function of I&L. Further, that the current splintered engineering disciplines which are separately organized and supported be reintegrated into a basic engineering structure to support the life cycle of the product.

4. The concept of industrial funding be utilized to provide incentive auditability and costing. It is further recommended that a

study be initiated to determine the feasibility of providing the field managers and Defense Contract Administration Services with a product-oriented funding structure. The panel determined that this type of funding approach provides the best incentive to efficient and economical operation. It also allows for better management.

5. Office Secretary of Defense study the matter of discipline in the QARAM field and develop a plan for implementing its needs in this area by promulgating, executing, auditing, and improving the plan.

6. Office Secretary of Defense study the problem of simultaneous audits of vendors for the same purpose between Department of Defense and other government agencies.

7. Department of Defense make a study of the broad application of the incentive approach as a means of improving management effectiveness.

NOTE: The above seven recommendations represent a summarization of Panel 1's 55 recommendations contained in Volume II.

REPORT OF PANEL 2

TITLE: Quality and Reliability Management in the Development Phase

OBJECTIVE:

To improve the methods within the Department of Defense of establishing requirements for and obtaining materiel with the required quality and reliability during the development program.

TOPICS DISCUSSED:

1. Adequacy of Operational Requirements
2. Stratification of Inherent/Operational Characteristics
3. Reliability Demonstration Requirements during Contract Definition
4. Reliability/Quality/Cost/Time/Performance Trade-offs
5. Storage Degradation Factors as Design Parameters
6. Incentives to Minimize Adverse Reliability and Quality Trade-offs
7. Parts for High Reliability/Long Life Applications
8. Time Phasing of Reliability and Quality Assurance Functions in the Program Cycle
9. Specification and Specification Guidelines
10. Resources for Advancing Reliability and Quality Technology, Reliability and Quality Programs, and Reliability Demonstration

SUMMARY OF RECOMMENDATIONS:

Panel 2 recommends that:

1. Operational commanders be encouraged to include operational information that affects reliability and maintainability design.

2. During the conceptual phase, reliability and maintainability requirements be refined by analysis and study of alternatives. After the SOR or QMR is promulgated, trade-offs should not be made without a complete analysis and synthesis comparing all the alternatives in the original proposed technical approach and others that may have become feasible in the interim.

3. An examination be made of existing data reporting systems to determine their capability to stratify the inherent and operational characteristics.

4. "K" factors associated with the operational use of selected combat systems and equipments be defined.

5. The services establish or place more emphasis on assurance programs that will minimize the degradation of inherent reliability of the design during the production, operational deployment and logistics support phases.

6. The requirements of MIL-STD-785 be adequately detailed during contract definition and in all succeeding program phases.

7. Continued research be sponsored by the services in improving cost-effectiveness techniques and modeling which consider reliability and quality as elements of effectiveness.

8. All services continue their efforts to refine pertinent data and techniques for use in cost-effectiveness trade-offs.

9. Management ensure utilization of reliability-quality cost-effectiveness trade-offs in the decision making process.

10. The services conduct studies on systems and equipments to determine the causes and extent of reliability degradation in storage so that programs can be developed to minimize degradation.

11. Research be supported to investigate accelerated testing techniques for predicting and measuring reliability degradation in storage.

12. Incentives be designed to minimize adverse trade-offs which affect quality and reliability.

13. Reliability and quality incentives be structured into contracts where possible.

14. Development contracts specify, to the maximum extent possible, the use of available ER grades of parts in all critical subsystems consistent with their requirements.

15. One hundred percent acceptance screening be required for all electronic parts not covered by ER specifications and used in critical subsystems. Provision should be made to accumulate and disseminate data generated from these tests.

16. The ER parts specification programs be expanded to other electrical and electronic parts, including microcircuits. Also, high usage mechanical parts should be studied to determine the feasibility of ER specifications.

17. Department of Defense investigate the methods of qualifying microcircuits based on commonality between different types of circuits.

18. Department of Defense determine the feasibility of screening procedures for mechanical parts, similar to those for electronic parts.

19. Department of Defense determine the feasibility of expanding the use of ER parts in other than critical subsystems to attain economic production runs and to ensure availability.

20. Preparation of the proposed Department of Defense/National Aeronautics and Space Administration Handbook of parts screening and burn-in procedures (for electronic parts) be accelerated.

21. The services develop appropriate guidelines which permit the operating agencies to develop critical reliability and quality assurance activities and requirements tailored to the specific projects and program phases.

22. The services place more emphasis on making reliability and quality assurance functions complementary to ensure completeness, timeliness and cost-effectiveness.

23. The services explore the feasibility of expanding the use of production testing techniques for specifications.

24. The Office of the Secretary of Defense provide the necessary resources in manpower and funding to expand efforts for the advancement of reliability and quality technologies, and ensure that each project identifies adequate resources for the R&Q program and its proper demonstration.

REPORT OF PANEL 3

TITLE: Quality and Reliability Assurance in the Production Phase

OBJECTIVE:

To improve the capability within the Department of Defense to establish requirements for and to obtain materiel possessing the necessary quality and reliability during the production phase.

TOPICS DISCUSSED:

1. Adequacy and Completeness of Technical Documentation for Procurement
2. Use of Systems Specifications MIL-Q-9858A, MIL-I-45208, MIL-C-45662
3. Cost Considerations in Production Quality Assurance
4. DOD Quality and Reliability Assurance Technical Procedures
5. Utilization of Customer Deficiency Reports
6. Quality Assurance Role in Overall Contractor Performance Evaluation
7. Role of Incentives and Warranties in Improving Quality
8. Role of Government Quality Assurance in Subcontracts
9. Contractor Quality Control versus Government Quality Assurance
10. Impact of Procuring Activity Product Evaluation on Administering Agencies
11. Adequacy of Government Control over Nonconforming Supplies

12. Quality Assurance Response to Fluctuating Workloads

13. Quality Requirements for Small Dollar Procurements

14. Procurement Quality Assurance Interfaces

SUMMARY OF RECOMMENDATIONS:

Panel 3 recommends that:

1. Office Secretary of Defense policies be issued to require that quality assurance personnel (a) review technical documentation for adequacy prior to procurement, (b) provide the required quality assurance contract clause input, and (c) arrange for the conduct of post-award conferences on major procurements to assure an understanding of product quality requirements.

2. Department of Defense activities continue to stress the necessity for sound configuration management practices, including adequate testing and evaluation of both materiel and technical documentation.

3. Department of Defense activities assure that quality assurance personnel participate in the development of technical documentation.

4. A Department of Defense committee be established to determine what additional quality assurance contract clauses would be beneficial for inclusion in ASPR, to improve technical documentation.

5. Office Secretary of Defense develop and publish uniform and definitive guidance for evaluating the effectiveness of a supplier's implemented program simultaneously with issuance of the program specification.

6. Office Assistant Secretary of Defense (Installations and Logistics) sponsor a study group to explore all facets of production quality costs of contractor and government, and to identify those elements of cost that should be maintained. This group should also develop a uniform policy relative to charging contractors for government costs associated with reinspections of rejected materiel and for the application of cost considerations in connection with the acceptance of nonconforming materiel.

7. Office Secretary of Defense establish an effective mechanism to assure that a single series of quality and reliability assurance policies and procedures is officially published and kept up to date.

8. Office Secretary of Defense establish a project for the development of a standard DD Form and appropriate procedures to be used as a transmittal sheet for submitting deficiency reports to contract adminstration services components.

9. All elements of Department of Defense review their deficiency reporting systems to assure that they provide for an expeditious flow of deficiency reports through quality assurance channels to either design agencies (design deficiencies) or contract administration activities (quality deficiencies) as appropriate.

10. Office Secretary of Defense establish a task group composed of quality assurance personnel to evaluate the contract administration quality assurance programs now carried out by the several Department of Defense elements, and develop a Department of Defense-wide program at the earliest practicable date. Procedures and resultant data recording and reporting methods developed should be compatible with Contractor Performance Evaluation (CPE) program needs.

11. Office Secretary of Defense establish a task group of quality assurance personnel to develop specific quality assurance factors for inclusion in the Department of Defense CPE program.

12. Office Secretary of Defense establish unifrom quality considerations for the Department of Defense-wide CPE program which include the best features of departmental CPE programs.

13. Office Secretary of Defense request the services and Defense Supply Agency to furnish the results of their experience with incentives and warranties relative to quality and reliability, in order to (1) identify quality and reliability evaluation elements during production for performance incentive contracts, (2) assess the overall impact of warranties with emphasis in the areas of cost, relationship to all types of incentives and appropriate application, and (3) use the data for developing guidelines for use of procuring activities.

14. Office Secretary of Defense should incorporate the following concepts in policy and procedural directives in order to clearly define the government quality assurance role in subcontracting.

a. Hold prime contractors completely responsible for the quality of supplies received from their subcontractors and vendors through definitive contractual language, nothwithstanding government source inspection.

b. Require government quality assurance review of prime contractor proposals for subcontracting.

c. Strengthen government review of prime contractor quality systems, including written procedures for control over the quality of subcontracted supplies.

d. Define the specific circumstances under which government source inspection may be applied.

e. Provide that requests for government source inspection contain complete identification of specific products, processes, critical characteristics and other requirements to be examined.

15. The ASPR Committee assure the development of standardized procurement quality assurance procedures reflecting the basic policies of Department of Defense concerning contractor responsibility for control of product quality. Procedures should be adaptable to different products and allow for government effort commensurate with demonstrated contractor effectiveness.

16. No action be taken by Office Secretary of Defense at this time to standardize the procuring activities' approach to product evaluation.

17. Office Secretary of Defense develop and publish uniform policy and procedural guidance for contractor and government control over nonconforming supplies and materials.

18. Office Secretary of Defense change the present policies and procedures concerned with procurement quality assurance manpower to provide a capability to respond to fluctuating workloads.

19. Office Secretary of Defense issue a policy statement establishing the conditions for the services and Defense Supply Agency to specify directed inspection activity at source. This policy should give cognizance to the relative importance of materials procured by the services and Defense Supply Agency in comparison to the total military mission of Department of Defense, and encourage efforts to minimize undirected mandatory inspections.

20. Office Secretary of Defense explore the practicality of funding the direct labor involved in the Contract Administration Services field quality assurance effort as an administrative expense of procurements.

21. An ASPR case be established to investigate simplified purchase procedures with the objective of allowing maximum use while maintaining necessary government quality protection.

22. The Deputy Secretary of Defense establish a task group to develop a total quality and reliability program covering the entire product life cycle, or to develop a system that will assure that adequate consideration is given to quality and reliability requirements throughout the product life cycle.

23. Department of Defense recognize the two methods of developing weapon systems (in-house and industry); and that there is a distinct difference in the technical documentation that results from each.

24. Assistant Secretary of Defense (Installations and Logistics) assure that timely action is taken to develop a uniform set of quality assurance procedures for application to the bulk of Department of Defense procurements in consonance with the intent of ASPR 1-108.

REPORT OF PANEL 4

TITLE: Quality Assurance in Storage Operations

OBJECTIVE:

To assure the quality and reliability of materiel being issued for use from storage operations.

TOPICS DISCUSSED:

1. Quality of Material Upon Receipt by Storage Activities

2. Quality Deterioration of Material in Storage

SUMMARY OF RECOMMENDATIONS:

Panel 4 recommends that:

1. The concept of "storageability" be defined and standardized in the Research and Development phase and that these requirements be given visibility and incorporation within the production technical data package.

2. Department of Defense take necessary action to (a) eliminate or reduce drastically the awarding of "acceptance at destination" contracts, including as a minimum all items, which if defective, would cause malfunctions or losses of military weapons and combat equipments, or (b) amend Department of Defense Directive 4155.11 to require all storage activities to inspect and/or test material received under "acceptance at destination" contracts at the time of receipt from vendors/contractors, and provide the resources to do so.

3. Department of Defense Directive 4155.11 (Paragraph V.B) be amended to delete authorization to combine quality assurance functions with other storage operations, if the intent of the directive is to require independent quality and reliability management.

4. Department of Defense Directive 4155.11 be amended to specify those quality control and reliability functions to be performed by a storage quality control organization.

5. Material being procured for storage activities (or for the operating forces) be marked for identification by Federal Stock Number, where such numbers have been assigned.

6. Material managers such as Commodity Managers, Project Managers, Project Officers, System Program Director, etc., be required to provide storage activities with Storage Serviceability Standards for material receipt, storage and issue in storage operations. These standards must define the minimum level to which deterioration can progress without impairment of serviceability and user satisfaction.

7. Utilization of storage and user test and evaluation data be made mandatory and that necessary arrangements be made at the Department of Defense level to utilize skills and facilities unique to any one service by all services in the quality evaluation of stored and service-held material.

8. Results of routine periodic storage testing of complex items (particularly electronic) be investigated on a selective basis and that the reliability degradation from these tests be weighed versus the quality assurance gains.

REPORT OF PANEL 5

TITLE: Quality Assurance in Maintenance Operations

OBJECTIVE:

To assure that material reconditioned, maintained and modified for the Military Services meet requisite quality.

TOPICS DISCUSSED:

1. Consistent Quality Assurance at all Echelons of Maintenance
2. Continuity of Consecutive Modifications
3. Inspection Cognizance for Contract Maintenance
4. Reliability Management relating to Maintenance
5. Relationship between Reliability Analysis and Preventive Maintainenance
6. Reconditioning Standards
7. Quality Standards for MAS (Military Assistance Sales) and Grant Aid Materiel
8. Improved Reconditioning/Serviceability Standards for Attribute Characteristics
9. Use of Contractor Rejected Material in Maintenance Activities
10. Impact of Contract Waivers on Maintenance
11. Quality Control/Inspection Skills Gap

12. Reducing Maintenance Workload Through More Complete "Use" Instruction

13. Maintenance Technical Data

14. Deficiency Data Feedback

GENERAL BACKGROUND:

The areas identified for consideration by this panel cover organizational policy and procedural responsibilities for the maintenance of material after it initially enters the Department of Defense inventory. Included are functions performed by government depots, government activities in support of maintenance and rebuild under contract, and those maintenance and modification functions carried out by or in support of Military users.

During the past two decades, many significant changes have taken place in the operation of the maintenance/modification programs throughout the Department of Defense. Changes in logistic concepts, procurement and storage practices in support of maintenance operations, and the tremendously increased costs and rapidly increasing complexity of defense equipment have had a very profound effect on defense maintenance operations. These changes have had considrable impact on quality control in the maintenance area, and strengthen the need for more effective quality control operation in this most vital area.

The facilities, skills, and equipment required to support material maintenance varies, depending upon the type of equipment involved, and the amount and complexity of the maintenance/modification involved. The work is categorized and scheduled accordingly, ranging from formal, complex specialized repair activities to those routine actions performed by the using tactical or defense element. For purpose of this study, all maintenance is identified as:

Depot maintenance
Contract maintenance
Unit or organizational maintenance

Contract maintenance describes the process whereby resources required for the performance of maintenance, repair, overhaul and modification of material in the Department of Defense inventory, and not currently available within the government's industrial complex, is

acquired under contract with commercial repair institutions outside the Government. In effect, contract maintenance is an extension of the Government's organic maintenance capability, and as such, cannot be conveniently divorced from the administration of the overall (total) program.

In past years, an increasing proportion of the depot workload has been accomplished by contract. Defense-wide figures are not readily available, but in the USAF, approximately 48-52% of the maintenance dollars is obligated to support of contractor performed maintenance/modification.

The magnitude of the DOD maintenance operations and the importance of quality control in the maintenance area is best highlighted by examining some of the current statistics relating to maintenance within DOD.

There is an estimated total of 4.5 million Line Items of equipment currently required to support the US defense program. About 15% of these are recoverable (repairable). Of this amount, approximately half can be repaired locally. The balance (7-8% of total) require depot (or contract) level repair and must be included in the maintenance management workload. To provide the required maintenance support of the DOD's estimated $105 billion inventory in weapons and equipment, an annual budget approximating $12 billion is required (based on FY 66). This figure includes direct labor and replenishment items only, but does not include the cost of facilities, services, training, etc. Considering only labor and material, maintenance costs represent approximately 25% of the annual defense budget, and involves approximately 900,000 personnel, or 1/4 of total DOD manpower.

While aggregate manpower figures are not readily available, it can be shown that a minimum of 10%, and in some cases upwards of 16% of the maintenance workload is allocated to accomplishing inspection/quality control. Based on a conservative, generally accepted ratio of 10%, a minimum of $1.2 billion and 90,000 manyears (2.4% of the annual budget and 2.5% of the manpower resources) available to the Dept of Defense are therefore required annually to support this maintenance quality control workload. Because of this very heavy proportionate commitment of DOD manpower and budget, it must be concluded that effective quality control management is essential for maximum operating cost effectiveness.

SUMMARY OF RECOMMENDATIONS:

Panel 5 recommends that:

1. A DOD directive be prepared that firmly establishes organizational stature for all echelons of maintenance quality assurance compatible with generally accepted and proven methods of quality assurance management. It should be patterned after, for example, NavShips Instruction 5450.148, Standard Naval Shipyard Regulations, which recognizes the importance of organizational autonomy for the quality assurance function in support of progressive, dynamic quality improvement programs. In supplementing this recommendation, an objective operating manual or handbook should be issued describing operations, responsibilities, means of communication, appraisal, etc. Finally, the problem of staffing this function with superior civilian and military personnel should be met head-on with the creation of formidable positions of executive importance.

2. A centralized control be established for all actions immediately subsequent to formal issuance of maintenance modifications. This control should be in the form of a system that prevents modifications to be effected out of sequence and must consider the attendant problems contributing to the dilemma such as state of completion of fabrication or test, existing inventory, recall of documents made obsolete as the result of the modification.

3. The Services/DCAS/OSD follow through on the original concept to reassign maintenance contract administration to the parent Service for those contractor facilities primarily engaged in specialized maintenance, repair, overhaul and modification.

4. Quality and reliability requirements for depot maintained items be developed that relate in a logical manner to those invoked at the initial productive phases and with due consideration given to the influences of usage, changes in mission objectives, substitution of different material, etc.

5. OSD issue a policy instruction that makes specific reference to the working relationship between quality assurance and reliability and maintainability and it should clarify and consolidate requirements now appearing in DOD Instructions 3200.6, 3200.9, 4100.35 and 3231.1 to include all reparable systems, components, equipments procured by the DOD. This policy should emphasize the importance of more active participation of capable quality control

personnel in the normal process of work planning from design through ultimate fabrication and test.

6. A statement of consistent policy be effected by OSD regarding reconditioning standards along with adequate procedural quality assurance guidance for commodity managers in facilitating ultimate development. Consideration of acceptable wear tolerances for important functional characteristics should be given in the generation of a standard format suitable for use by both services and industry.

7. Specific regulations governing quality requirements be provided for military assistance sales and grant aid materiel along with service directives that reflect these requirements as assurance of mutual understanding and agreement between customer and vendor.

8. Policy require the development of interpretive standards in the inspection of such attributes as color, finish, damage, etc. A clearing house should be designated to function as coordinator for development and implementation of numerous service-wide standards. A formal determination is needed of the extent of existing standards, both DOD and industry, along with a formal refinement of present practices. The Services and DSA should vigorously effect programs aimed at quantifying attributes data that appear in maintenance reconditioning standards.

9. Policy be established pertinent to formal disposition of contractor "out of specification" material along with appropriate modification to ASPR to prevent delivery of used or surplus material without prior Government approval.

10. A study group be established by OSD to evaluate the problems attendant to adequate control of waivers of defects. This group would additionally be required to formulate working procedures that would enable in-process identity of previous actions that may have resulted in waivers made on important characteristics.

11. Programs be started to promote development and construction of adequate test equipment that also extends the potential and capabilities of the inspector. The Defense budget should allow for procurement of unique and, often, elaborately designed test gear required in specialized applications. Individual and collective influences of present equipment, skills levels, mission constraints, etc. should be isolated and identified in efforts at maximizing the

design configuration. This includes a requirement that the Services and DSA place urgent priority on quantifying requirements of reliability and maintainability.

12. Policy be developed relating to required training and orientation in the use and subsequent maintenance of complex equipments so as to lessen the likelihood of equipment failures occurring as a result of abuse or misuse.

13. Maintenance Technical Manuals be issued in such a manner as to standardize quality assurance requirements and provisions. This points the need for a crisp format that adequately expresses these requirements in common language. Also, the Services should jointly investigate the problem of adequacy of engineering drawings considering maintenance quality control and accepted engineering design practices.

14. OSD initiate action to examine the existing deficiency reporting systems to determine which of these will provide the most complete and timely feedback of quality control deficiency data. This system should then receive priority attention for service-wide implementation.

15. OSD take action to address the attendant major problem of coordinating the data feedback systems required by DODD 3232.1 - Department of Defense Maintenance Engineering Program; DODD 4100.35 - Development of Integrated Logistic Support for Systems and Equipments; DODI 7220.14 - Uniform Cost Accounting for Depot Maintenance; DODI 7730.25 - Equipment Distribution and Condition (EDAC) - Statistical Reporting System; Proposed DOD - Configuration Accounting and Proposed DOD - Resources Management; and to place these actions in harmony with the intent of DODD 5000.11 - Data Elements and Data Codes Standardization Program and DODI 5000.12 - Data Elements and Data Codes Standardization Procedures as they pertain to data element standardization.

REPORT OF PANEL 6

TITLE: Reliability and Maintainability Assessment

OBJECTIVE:

To recommend actions essential to the quantitative assessment of materiel reliability and maintainability during all phases of its life cycle.

TOPICS DISCUSSED:

1. Consistent assessment criteria for Reliability/Maintainability
2. Reliability/Maintainability Prediction Techniques
3. Test Programs as an Input to Reliability/Maintainability Assessment
4. Field Data Feedback
5. Reliability and Maintainability Data Storage and Retrieval
6. Research in and Validation of Reliability and Maintainability Assessment Techniques
7. Use of Reliability and Maintainability Assessment Results by Management
8. Interservice Coordination

GENERAL BACKGROUND:

DOD currently spends enormous sums on repair and maintenance. Current estimates of this run to $12 billion per year. Much of this can be saved by more realistic assessment of reliability throughout the life cycle of equipment.

Better assessment is needed to blend the usually over-optimistic design and prototype probability prediction beforehand, with the more realistic production and usage reliability determination afterwards. Advanced prediction techniques are necessary to avoid troubles experienced in previous systems. Improved reporting is necessary to pinpoint the big money users so that appropriate action can be taken on current systems, as well as to improve the prediction process for future ones.

Reliability and maintainability as addressed by Panel 6 consists of a quantitative prediction and/or measure of these parameters. Only those activities associated with quantitative assessment are covered, thus eliminating such qualitative assessment techniques as design and program reviews.

The progress of the reliability and maintainability disciplines from art to science is measured by the ability to quantify those parameters. During the past few years, OSD has exerted continuing pressure to quantify reliability and maintainability. As a result of these pressures, virtually all new development contracts contain quantitative reliability and maintainability requirements and most weapon systems periodically report status against these parameters. Thus, DOD is nearing the point where all decisions regarding development of new systems/equipments are made with the aid of quantitative estimates of reliability and maintainability. The next step is to extend this discipline through all levels of management and throughout the life cycle.

Under the guidance of OSD, the departments have made considerable progress in the improvement of reliability and maintainability assessment techniques. However, Panel 6 concluded that there were a number of serious weaknesses in the DOD reliability/maintainability assessment program. The progress being made is far too slow to keep pace with management's need for continuing, consistent, and accurate knowledge of status against these key parameters.

Panel 6 concluded that DOD cannot develop an adequate

reliability and maintainability assessment program without an enhanced in-house capability. The acquisition of this capability should be a major long-term goal of DOD. Achievement of this goal cannot be legislated, however. If the proper environment exists, management at all levels will conclude that additional in-house capability is needed and will act accordingly. Implementation of the recommendations of the panel should materially contribute to the creation of that environment.

SUMMARY OF RECOMMENDATIONS:

Panel 6 recommends that:

1. OSD issue an instruction requiring consistent assessment of systems/equipments throughout their life cycle.

2. The Services give high priority to the conduct of certain reliability and maintainability prediction research studies.

3. The Services intensify efforts to correlate reliability and maintainability predictions to measured results during the operational phase.

4. MIL-STD-785 be strengthened by requiring additional coordination in test planning between reliability and maintainability personnel and personnel responsible for test requirements prior to the conduct of tests.

5. The Services increase use of reliability and maintainability demonstration requirements for more types of equipment, including reprocurements and replenishment spares.

6. Each Service conduct an objective study of its field data feedback program designed to re-orient these programs to provide all data required for effectiveness assessment.

7. OSD sponsor a research study of the problem of accurate measurement of the reliability and maintainability of fielded systems.

8. The Services continue their use of special reliability and maintainability monitoring programs, especially during the operational phase.

9. The Services improve the reliability and maintainability coverage of their respective field data feedback systems.

10. DOD publish a handbook indexing all reliability and maintainability data banks which would provide assessment personnel with specific information on how to obtain needed data.

11. DOD establish a communication network to provide for rapid interchange among decentralized data banks.

12. The Services intensify their research efforts in reliability and maintainability with emphasis on the problem areas identified in the Panel report.

13. OSD establish a line item in the budget structure for "Research and Technique Development for Reliability and Maintainability."

14. The Services place emphasis on the establishment and use of assessment techniques which are specifically designed to aid the executive in the decision-making process.

15. The Services undertake continuing programs to train all levels of management in reliability and maintainability techniques and terminology.

16. DOD establish and chair a tri-service reliability and maintainability assessment steering committee to continuously exchange information, coordinate and advise OSD and the departments regarding research needs, methodology and terminology and data system design.

REPORT OF PANEL 7

TITLE: Personnel and Training

OBJECTIVES:

To recommend policies, procedures and actions essential to insuring qualified personnel for the management and implementation of quality and reliability operations.

TOPICS DISCUSSED:

1. The Diagnosis of the Personnel and Training Problem as it Relates to Quality and Reliability in the Department of Defense.

2. A Total Quality and Reliability Career Program.

3. Acquisition, Development and Retention of Quality and Reliability Skills.

GENERAL BACKGROUND:

In the initial meeting of Panel 7 to discuss the area of Personnel and Training in Quality and Reliability Management, it became readily apparent that a great difference of opinion as to the role of quality and reliability existed among the panel members; and it was felt these differences reflected the general atmosphere in which quality and reliability activities function today. Little or no progress could be made until there was general agreement as to the nature of the role of these skills across the total logistics spectrum. For example, opinion ranged from the abolishment of the 1900 Series for Quality Control Specialists on the one hand, to the opinion that this particular area should be the one of major emphasis. Convincing arguments were expressed supporting both views.

It is well known that the first step in solving any problem is to clearly define the problem and its objectives. It is useless to develop a cure until some diagnosis of the nature of the existing illness

has been made. In the case of the functions of quality and reliability, it was determined that this diagnosis must take the form of definitions of the roles which these skills are to play in the total product effectiveness program.

Under existing conditions, the task of insuring "qualified personnel" for the management and implementation of quality and reliability operations is an impossible one, since the job for which these individuals are to be qualified has not been clearly defined. An organization must specifically describe the job to be done in terms of its requirements. One of our major problems is to attempt to train or acquire talent only to find it is "not qualified" for the job to be done because we have not described what we want or because it is not possible to match the skills to the job.

Thus, the use of product effectiveness skills must be carefully defined: Is the individual to be an effective part of the team that contributes to decisions on design, on procurement and production, in the development of storage and maintenance standards? If he is to be totally effective, he must. If not, many of the basic premises upon which the quality and reliability functions are based are out of date.

It became obvious in panel discussions that among the many changes taking place within the Federal Establishment is the combining of a variety of disciplines into a single program, which the panel chose to call the Product Effectiveness Program. This combination of functions conceptually has not taken place at the Department of Defense level. However, it has appeared in many organizations where complexity of product has demanded it. Specifically, this combination of functions can be seen in such organizations as those responsible for all Army missile systems, the Navy Polaris, and the Air Force Minuteman. A recent study conducted by a panel of officers reporting to the Commanding General of the Army Materiel Command in Washington culminated in a recommendation that throughout the entire Department of Army, this combining of like functions be effected.

Therefore, Panel 7 gradually evolved from "How do we acquire, develop and retain quality and reliability skills?" to one of "What is necessary in order that an effective program for the acquisition, development and retention of quality and reliability skills can be described?"

SUMMARY OF RECOMMENDATIONS:

Panel 7 recommends that:

1. A clearcut policy be established with regard to the roles and responsibilities of the disciplines of quality and reliability as applied across all elements of the logistics spectrum, and that these disciplines be managed as a key Department of Defense program.

2. An Executive Agent for the Product Effectiveness Career Management Program be established with a broad charter to include such things as establishment of a career development program with mandatory selection criteria; unification of existing in-service training; and expansion of the curricula to meet defined product effectiveness program requirements.

REPORT OF PANEL 8

TITLE: Metrology and Calibration in Quality and Reliability Operations

OBJECTIVE:

To recommend action required for the effective integration and utilization of metrology and calibration in quality and reliability operations.

TOPICS DISCUSSED:

1. Identification of New Measurement and Calibration Requirements

2. a. Selection of Proper Test and Inspection Equipment and Measurement Processes

   b. Adequacy of Test Equipment and its Usage in R&D Activities

3. a. Promulgation of Uniform Specifications Controlling Contractors Calibration Systems

   b. Inclusion of Requirements for Calibration Systems in Small Business and R&D Contracts

4. Provision of Metrology Support to Contract Administration Personnel

5. Establishment of a Central Point of Contact within Office Secretary of Defense Responsible for Overall Policy for Metrology and Calibration and for Coordination with Other Government Agencies

GENERAL BACKGROUND:

The deliberations of Panel 8 focused on consideration of the degree of which metrology and calibration have been woven into each stage of the life cycle of defense materiel. Metrology, defined as the science of measurement, concerns itself with the selection and application of test and measuring devices from which quality decisions are made; thus it can be seen as an element extremely essential to the quality and reliability of defense materiel. The determination of product quality and the assessment of reliability levels depends principally upon measurement processes comprised of test equipment and testing techniques.

Just as a day's production from a manufacturing process would not be accepted without evidence that the process is in control, so the output of a measurement process should not be accepted without some evidence that it is in control. The process that should be focused upon is the one which measures the item; and this process will include procedural, environmental, and other factors. Each link in the chain from raw material, to finished product, to operational use, that involves measurement, should have adequate evidence that the measurement processes used are in control.

Control of these measurement processes is assured by the application of metrology to the proper selection of equipment and methods, and by the application of calibration in maintaining test equipment to original operating tolerances. Just as the National Bureau of Standards has the responsibility for providing the basis for a National Measurement System, so the calibration laboratories of the Department of Defense have the responsibility of insuring the accuracy, consistency, and adequacy of that part of the measurement system that affects the national defense.

Panel 8 is especially concerned that adequate control does not exist at the present time to assure the proper selection of test equipment, and that additional emphasis is required in the application of metrology and calibration at all stages of the life cycle of defense materiel. While it is recognized that considerable calibration effort is being directed within Department of Defense toward the operation and maintenance segment of the life cycle, this effort is only now beginning to prove effective in controlling the quality of defense measurements at that stage of the cycle.

Of even greater concern to the Panel is the observation that in research and development operations, selection of testing equipment

appears to be done without the aid of knowledgeable metrologists and without the support of adequate calibration facilities to assure that whatever equipments are selected, are maintained to their original accuracy capabilities. The determination of measurement problems early in the life cycle allows resolution lead time that, under present conditions, rarely exists. By the use of skilled metrologists, avoidance of unnecessary measurement problems critical to combat effectiveness can be assured.

The Panel noted particularly that in research and development operations, measurement data is frequently the product and that "make or break" procurement decisions frequently are based solely on these data. Pure research, exploratory development, advanced development, engineering development, and operation systems development increasingly depend upon measurement data. It is essential that these measurement data stem from controlled measurement processes which are consistent and compatible. It is the mission of metrology and calibration organizations and operations to provide services which result in control, conformity, continuity, and consistency of defense measurement processes. More careful application, support, and augmentation of these limited resources are essential if improved product quality and reliability are to be expected.

SUMMARY OF RECOMMENDATIONS:

Panel 8 recommends that:

1. Department of Defense issue a directive or military specification requiring systems development contractors or agencies to identify measurement requirements early in the development phase.

2. Department of Defense (a) publish a technical guide for Government and contractor engineering personnel to aid in the proper selection of test and inspection equipment; (b) require R&D and design engineering personnel to consult with metrology and calibration personnel in the selection of test equipment; (c) require that test and measuring instruments at R&D activities be subject to the same quality control measures as are now required of instruments at production, maintenance and field activities; (d) revise appropriate military specifications to require controls over the selection, performance and application of test equipment in DoD contracts; and (e) develop a training course for engineering and contract administration personnel in the selection and application of test and measuring equipment.

3. Department of Defense revise Military Specification MIL-C-45662A, Calibration Systems Requirements, and adopt it as the standard calibration specification to be inserted in Department of Defense and National Aeronautics and Space Administration contracts, including those for small businesses and research and development.

4. Department of Defense develop and promulgate an orientation program to aid engineering and management personnel in recognizing the effect of metrology and calibration on product quality.

5. Department of Defense publish a catalog of available metrology and calibration training courses, develop a training course for the selection and application of test and measuring processes, and ensure that appropriate engineering and contract administration personnel attend these courses.

6. Office Secretary of Defense designate a specific office, Office Assistant Secretary of Defense (DDR&E, ASD (I&L), or the Department of Defense Quality and Reliability Council) for policy direction and to serve as a central point of contact for metrology and calibration matters.

REPORT OF PANEL 9

TITLE: Quality of Technical Data

OBJECTIVE:

To improve the Department of Defense's capability to provide data to users that are suitable for the intended purpose, at lowest practical cost.

TOPICS DISCUSSED:

1. Role of the Contractor in Data Quality
2. Government Responsibilities in Data Quality
3. Training
4. Legibility
5. Data Warranty
6. Engineering Data Defects and "Rights"
7. Lack of Uniformity in Data Requirements
8. Third Party Evaluation of Data
9. Application of Zero Defects to Data
10. Industry Viewpoints on Data Adequacy
11. Use of Data in Relationship to Quality Techniques
12. Matching Data against Hardware

GENERAL BACKGROUND:

The importance of technical data was recognized by the Secretary of Defense in the early 1960's when management responsibilities were assigned in the Office Secretary of Defense staff and early defense Directives issued. Study within the Department of Defense, assisted by Industry groups, and the Department of Defense Aberdeen Technical Data Conference, demonstrated the need for larger permanent staff at Office Secretary of Defense and led to the establishment in the summer of 1964 of the Office of Technical Data and Standardization Policy (OTDSP). This Office is located in Installations and Logistics but is responsive to both logistics and research and engineering needs.

Initial efforts of the Office of Technical Data and Standardization Policy, as they pertain to quality, were directed principally at placing a discipline on the ordering of data from contractors to obtain better definition of data requirements and prevent ordering of data in excess of needs. All data requirements (DoD Directive 5010.12) must be placed in on single form in all contracts, the DD Form 1423, and must be selected from a predetermined list of data requirements (Authorized Data Lists). Recently, the Office of Technical Data and Standardization Policy, recognizing the importance of data quality, established an interdepartmental committee to develop procedures to strengthen and make more uniform the data quality assurance practices of the Military Services.

By data quality, we mean that data delivered has utility for the purpose. Utility is affected by the formulation of the data requirement, the communication of the requirement to the contractor, the method of generation, the inspection and acceptance, and the handling of data before it is placed in the hands of the ultimate user. For data to have utility it must have the proper content, be in a readily usable form (format considerations) and be legible.

Technical data permeates every function and discipline in the Department of Defense. Because of the extremely broad range of kinds of data, the complexity of the subject in general, and the number of actions involved that have an effect on data quality, Panel 9 found it necessary to concentrate on selected aspects of data, and to exclude others, even though they may have significant impact on data quality. For the most part, we have emphasized the contractual aspects of engineering drawing acquisition, although peripheral subjects are included. The majority of the recommendations made apply to other kinds of data as well as drawings.

SUMMARY OF RECOMMENDATIONS:

Panel 9 recommends that:

1. Department of Defense develop and specify the minimum elements of an acceptable contractors data quality program in a military specification, preferably, MIL-Q-9858.

2. Department of Defense include a detailed statement of the Government's responsibilities for data quality in Department of Defense Directive 5010.12.

3. Department of Defense develop a Department of Defense handbook outlining procedures for reviewing adequacy of contractors technical data control system.

4. Department of Defense revise provisioning regulations to require that Supply Support Requests identify the method of procurement, justify the method, and provide data suitable to support it.

5. Department of Defense develop a data training syllabus for data inspectors.

6. The Armed Services Procurement Regulation Committee favorably consider a data warranty clause developed by Air Force/ Industry.

7. The Services use photorestoration processes for presently illegible drawings rather than redraw.

8. The Services continue emphasis on Government inspection for legibility using technically trained personnel.

9. Department of Defense continue emphasis on achieving uniformity in military drafting practices.

10. Department of Defense support and provide leadership to National Standardization efforts in drafting practices.

11. The Services use "third party" contractors to evaluate data only on a case-by-case basis. Such contractors should not be used for evaluation of technical content except under unusual circumstances.

12. The Services include data considerations in present Zero Defects programs.

13. Department of Defense consider objectively Industry comments on data quality that have been received.

14. Department of Defense expedite a project to expand the techniques of MIL-STD-789 (ASG) for Procurement Method Coding in a Department of Defense-wide document. Special quality assurance consideration should be given to items designated for competitive procurement.

15. The Services ensure that contractors data quality programs contain provisions to match data against hardware.

16. The Services review present contracts to apply present "rights" provisions of Armed Services Procurement when economically practical.

17. The Services validate drawings by building, testing, and obtaining feedback from the maximum number of items practical.

KEYNOTE ADDRESS
BY
MR. GEORGE E. FOUCH
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(EQUIPMENT MAINTENANCE & READINESS)
OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE (I&L)

Mr. Chairman, Distinguished Guests, and Panelists:

On behalf of the Director of Defense Research and Engineering and the Assistant Secretary of Defense (I&L), it is my great pleasure to welcome you to this Conference on Quality and Reliability Management. The degree of success of this Conference has been largely predetermined by the work that the chairmen and panelists have accomplished over the past six or eight months. Neither extended comment nor exhortation by me can substantially add to or subtract from the quality of that work. Thus, my comments will not be extended.

This is the sixth DoD-wide conference that the Office of the Secretary of Defense has sponsored since February 1962 in the field of materiel and management. These conferences have led to important improvements in management practices in the Department of Defense. They have led also, I might add, to improvements in the methods by which we conduct conferences. In former times, meetings of this kind have led frequently to severe frustrations; participants did not have time to explore fully their mutual problems in a period of three or four days. This Conference has been so planned that problems have been explored in advance of this Annapolis meeting. During the next few days, therefore, you will be primarily concerned with polishing the ideas and recommendations you have already formulated and exchanging views among panels.

We are most hopeful that this Conference will play the same role in Quality and Reliability Management that previous conferences have played in various other fields of management. The Defense Contract Administration Service, for example, has its roots in the procurement management conference at Williamsburg in 1962. Important advances have been made in technical data management as a direct result of the conference at Aberdeen in 1964. It is quite apparent that the highest levels of management of the DoD are

receptive to the recommendations that derive from conferences of this kind. You can be sure that your voice will be heard.

The objectives of this Conference have been spelled out quite clearly by the OSD-Army-Navy-Air Force-DSA-NASA Steering Committee. It may be useful to repeat these objectives so that all of us keep in mind exactly why we are here. They are fourfold:

1. To analyze the principal quality and reliability problems that confront the DoD;

2. Assess pertinent current efforts and proposed plans which are aimed at solving these problems;

3. Exchange ideas on solution of these problems; and

4. Recommend to executive levels of the OSD, the Military Departments, and DSA

a. appropriate and immediate actions to resolve specific quality and reliability problems, and

b. long-range plans and programs for improving quality and reliability assurance efforts.

As stated, these objectives are phrased in the somewhat stilted bureaucratese in which most of us indulge. Clearly, the real reason we are here is to promote, through improved quality and reliability management practices, the well-being of our country. Some months ago, Deputy Secretary Vance expressed this thought succinctly when he said:

> "The military security of the United States requires that we remain ahead of the technological competition for better and more reliable weapons systems -- and, above all, that we excel in managing the resources entrusted to us for developing and producing the vast amounts of materiel required to equip and maintain the forces needed for our military security."

It need hardly be said that few areas of management have a greater impact on the proper utilization of resources than quality and reliability.

This Conference has been convened at a particularly timely moment. As a nation we are all concerned with providing our men in Viet Nam with the supplies and equipment they need -- promptly and efficiently. Sometime ago, General Wheeler described Viet Nam as an event in "the longest War" - the war that has flamed and flickered since 1945. Locales have constantly changed -- Berlin, Korea, the Formosan Straits, Cuba, and now Viet Nam. But the bed-rock situation has not changed -- we have been repeatedly probed and challenged. This is a probing of our determination to protect the cause of human freedom. But, as Secretary Ignatius recently commented:

> "This determination is not solely a matter of military action. Not all of us can be in the jungles and swamps of Viet Nam. No less essential is determination in the everyday jobs of fabricating, maintaining and furnishing supplies and equipment to those who bear the heat and burden of the day. We are determined that the job will be done effectively."

Again, it is quite apparent that quality and reliability management play a central role in providing the effective support to Viet Nam to which Secretary Ignatius made reference. This is especially true with respect to the hour-to-hour, day-to-day effectiveness with which we examine and test the supplies and equipment flowing from industrial and military industrial activities to the operating commands.

I said that this meeting has been convened at a particularly timely moment. Apart from Viet Nam, we as a nation have become increasingly concerned with the quality and reliability of the products we use in our everyday living. This concern is quite apparent from reading the daily news reports, not to mention irate letters to editors regarding some less-than-satisfactory consumer products and services. This Conference is, of course, addressed to problems of the DoD. It may well be, however, the ideas and suggestions that stem from this Conference will make an important contribution to the continued progress of our national economy. In my work in the OSD I have been encouraged and inspired by the knowledge that techniques and concepts developed originally for defense purposes have contributed importantly to social and industrial progress. This has been notably true with respect to theory and practices related to quality and reliability. Accordingly, as panelists and participants in this Conference, you are privileged to contribute, directly and indirectly, to improving the well-being of the American people.

Let me say a word about the climate of this Conference. First and foremost -- from the very beginning we have encouraged a free expression of opinion. We are meeting here as free spirits, working in a climate of free inquiry. I hope that this climate of free expression, as well as tolerance of each other's points of view, will be maintained during the next few days. There is no reason why we cannot be completely frank in our opinions. This is particularly true at a meeting of this type; we are here as a family of people examining how we ourselves conduct our affairs. This is an in-house self appraisal. Let us, therefore, be forthright and tolerant. If any single panelist strongly dissents from the consensus of his colleagues, he is invited to submit a separate statement of his views. These minority statements will be carefully studied as the Office of the Secretary of Defense, the Military Departments, and the various Agencies review and implement the Conference report. Understandably, we hope for consensus. But we do not want consensus at the price of full ventilation of opinion. We hope that this Conference will generate practical and useful recommendations for the continued improvement of quality and reliability management practices.

Possibly a keynote speaker may be forgiven if he takes a few moments from his allotted time to explore some subjects that particularly concern him. First, we all know that from time to time there occurs in the public press or elsewhere a rash of questioning statements regarding the quality and reliability of military or space supplies and equipment. These statements, including some that have originated from my office, have served a useful purpose. They negate any tendency towards complacency. But, they pertain only to limited segments of materiel. Such reports do not reflect the big picture. We lack a device for surveying this larger scene. We need a continuing and sensitive system for measuring the quality and reliability of the products we acquire from industry to produce, store and maintain in in-house establishments. This is not to suggest that the departments and various agencies do not have up-to-date quality and reliability information on selected products. But, comprehensive information is not readily available to upper level management throughout the Department of Defense. In recent years I have chaired semi-annual meetings at which representatives of the Departments and DSA have met and exchanged the quality and reliability information they have acquired. The fact remains, however, that we lack a continuing program to keep track of trends in quality and reliability. In former times we could justify this deficiency by reason of lack of an adequate data collecting and analyzing capability. This kind of justification has less substance today in this era of computerization.

Secondly, the Department of Defense expends considerable resources in making sure that products and services are useable and reliable. We have sizeable programs aimed at combating trends towards defectiveness in production and maintenance. We don't know, however, what defectiveness actually costs. The joint DoD-NASA Quality and Reliability Assurance Committee recently recommended that a study be made to assess the economic dimensions of defectiveness. Such an assessment would be highly useful not only to NASA and to the DoD, but to the Government generally.

Thirdly, I have been a little concerned that we may be moving in the direction of a paper-heavy bureaucracy in DoD quality assurance. The establishment of the Defense Contract Administration Service has improved the ability of the DoD to conduct its business with industry more efficiently. We have reason to be concerned, however, that Government quality assurance might become entangled in a web of well-intentioned but excessive guidance from technical and procuring agencies. It would appear to me that the first line of defense against inferior quality and reliability is the contract. If the contract and the related specifications are not clear, complete and explicit, we can hardly expect the contractors to give us what we want. No amount of quality assurance by the Government will compensate for deficient contract packages. Equally important, the Government quality assurance activities must have strong technical competence and flexibility in utilizing that competence when servicing the Army, Navy, Air Force, and DSA. I will not expand on this -- I am simply mentioning this subject with the thought -- paper work should not supersede attention to the essentials of inspection, process control and testing.

Fourthly, as I have indicated on other occasions, I am convinced that something has to be done to interrelate and possibly integrate the many management systems and movements that keep cropping up. These movements are responses to real problems. But I am apprehensive lest people in Government and industry become disenchanted with the new management techniques for reasons of non-integration. I am making reference, for example, to such functions as configuration control, value engineering, PERT, Zero Defects, standardization, cataloging, total package procurement, specification management, total logistics support, quality control, reliability and maintainability. And this does not exhaust the litany of new systems, methods, and movements that we all know about. I repeat that each of these represents a response to a real problem. In that respect they contribute to management effectiveness. However, these various techniques appear, at times, to be ends in

themselves, isolated from each other as well as from the central objectives of management. Possibly this Conference might come up with ideas regarding how we can capitalize to the maximum on the intrinsic dynamism of these movements without perpetuating competing sects and cults.

Fifth, I have shared the apprehension of other persons in the DoD that we might inadvertently sacrifice quality for competition. In a letter to the Secretaries of the Army, Navy and Air Force, and Director of the DSA, Secretary McNamara recently said that he is "proud of our continued high record of price competition," but he "does not want this record to be at the expense of quality of product or quality of performance." Apart from use of preaward surveys and other techniques to prevent the selection of contractors with marginal capability, we can protect quality by improving specifications, by enforcing contracts and specifications firmly but fairly, and by utilizing the services of our quality assurance personnel more effectively where they can do the most good; namely, at the plant level. There is need, as Secretary McNamara has indicated, for continuing attention to the problem of selecting competent sources. There is also need for equally strong attention to the problem of enforcing provisions of contracts through more effective utilization of quality assurance personnel.

Lastly, I want to mention the need for attention to the human dimensions of reliability. The Zero Defects Program has demonstrated the widespread concern of people in Government and industry for personal identification and recognition. People resent being depersonalized. Yes, they want, first and foremost, adequate compensation for their work. But they also want something more. They want to be recognized as individuals. They want to feel that they -- and their ideas -- play a useful and recognizable role -- however modest -- in the organizations of which they are a part. The human aspect of reliability and quality management is a vast, complex and somewhat uncharted subject. Certainly it is a subject beyond my ability to treat adequately during these brief comments. It seems to me, however, that in various ways -- through training, through improved personnel practices, through award and recognition programs -- we could do a lot more than we are doing on the person-to-person level to improve quality and reliability.

I have imposed on your good will for the last three or four minutes to mention some of the things that personally concern me. I am not suggesting, however, that these problems have greater

urgency than the many subjects you have discussed at your meetings prior to coming to Annapolis.

Two days from now -- on Thursday -- you will reconvene in this room to present your reports and recommendations to an important cross section of executives of the DoD. Subsequently, these recommendations will be incorporated into a conference report. The published report can be expected to have a long-term effect -- hopefully a favorable effect -- on quality and reliability management. We expect that your comments will be expressed in clear, forthright language and that your recommendations -- whether of the short term or long-term variety -- are reasonably amenable to implementation. The adoption and implementation of your recommendations will be expedited considerably by the clarity and practicability of what you have to say.

In the final analysis, however, your recommendations will be judged by one criterion; namely, their utility in providing our armed services with supplies and equipment at minimum cost. It is well to recall the commission originally given to Secretary McNamara by President Kennedy, and reaffirmed by President Johnson. Secretary McNamara was directed to:

1. Develop the force structure necessary to our military requirements without regard to arbitrary budget ceilings.

2. Procure and operate this force at the lowest possible cost.

We are here to rethink policies and procedures in quality and reliability management with special attention to the second sentence of the Kennedy-Johnson mandate, "Procure and operate this force at the lowest possible cost."

May I thank the Conference Director, the Steering Group and the Chairmen and panelists for their excellent cooperation and initiative in planning and preparing for this conference. I hope these three days will be rewarding to you as participants and to the people we ultimately serve -- the armed forces on the frontiers of defense overseas and our neighbors and the American public here at home.

KEYNOTE ADDRESS
BY
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DEPUTY DIRECTOR
DEFENSE RESEARCH AND ENGINEERING

Much of the emphasis given to Reliability and Quality Assurance in the past ten years stemmed from our Defense missile programs and, more recently, from our space efforts. However, let me assure you that the importance of Reliability, Maintainability and Quality in the many other Defense systems and equipment is at times even more critical in view of their required effectiveness and the many lives that may depend on these factors.

You know that one of the prime objectives of the DoD is the acquisition and deployment of adequate weapon systems in a proper time frame at reasonable costs. By "adequate" we mean responsive to the specifications which in turn must reflect our operational needs. And in assuring reasonable costs we must consider cost of ownership over the system life.

Achieving these objectives and policies in the current environment demands techniques for improved program management and technical control. Very briefly our situation is one of (a) complex, high performance, and quite expensive systems; (b) these are resulting in increasingly complex contractual and management arrangements and; (c) we are experiencing costly maintenance and logistic support. The quantitative approach and analytical techniques for reliability and maintainability, though incomplete in some areas, have proved themselves as powerful tools for design and management decisions.

I wish to suggest that there are several broad challenges to Reliability and Quality Assurance today. We need to continue the improvement of analytical and audit techniques for Reliability and Maintainability; and, these improved techniques need to be fully integrated into the design and engineering, into configuration management and change control, and into the overall program management process. Refined and improved quality assurance quantitative techniques are needed especially in the extreme conditions where normal statistical techniques become unusable. Also we need better control in the operational portion of the life cycle; that is, in maintenance, supply, and storage.

I would like to offer two suggestions in the form of specific challenges to reliability and quality assurance:

First - Full use is not being yet made of recently developed quantitative methods. This may be due to the fact that little time has elapsed since changed instructions were issued. Education is needed in the use of these improved analytical and audit techniques for reliability, maintainability and quality assurance. The efforts expended in their development are wasted unless they are put to use by all levels of line management in program decisions, by engineers in their designs, by procurement officers invoking these contractually, by maintenance and by other logistics support people. You, who are the specialists, and who form the really significant competence in these techniques and methods must increase your efforts to educate the line managers, the designers, procurement officers and the operational support types. You must assist the various groups in the use and continued development of advanced techniques (i.e., predictions, apportionment, trade-off and system analysis, assessment of reliability and maintainability, design review, etc.).

A Second Suggestion - recognizes the continued need for refinement and that gaps still exist in the technology. These are the areas to which we must direct our studies and research. I have in mind the ever present problem of adequate testing within the constraints of schedule and funds. This is extremely critical where systems are designed for very long MTBF or Mean Life (satellites, communications switching systems, radio receiving equipment, etc.). Schedules and costs do not permit long term reliability testing using conventional test plans or sometimes, even the use of truncated test plans. Similarly, in the parts area there are some extremely long life electronic devices, including, some of the recently developed microelectronics integrated circuit configurations. We can no longer afford the long term, mass testing which has been developing in the past few years. We need newer test and inspection methods which will permit assessment of the life characteristics of these devices from short term tests or inspections.

Going back to systems, we are developing expensive, complex, expendable systems which are not susceptible to reliability assessment using standard statistical test plans. Assessment with limited test data is a real problem needing study and probably, innovation. Techniques such as accelerated testing, design analysis, and physics of failure correlated to failure-rate at the equipment and systems level have not been fully exploited.

With respect to testing, particularly in the equipment and systems areas, the concept of integrated test plans should be employed. Further, optimization of these plans based on previous reliability information of component parts could result in substantial savings in terms of cost, time and facilities. And I might add, with more meaningful results.

In the prediction area, reliability prediction in the mechanical and hydraulic areas needs emphasis.

Of course, design techniques and materials which will circumvent principal failure mechanisms or shield devices or even full equipments, from damaging environments are areas of continued research; these can have substantial effect on your areas of responsibility.

One last comment on techniques - we must be certain to keep these recently developed techniques current and compatible with other advances in defense systems technology; for example, reliability prediction techniques, process control and quality assurance techniques applicable to microelectronics and solid state designs.

I have gone to a degree of detail for several reasons. Techniques for predicting, apportioning and measuring reliability and maintainability give us excellent tools to increase the effectiveness of our weapons systems. But these same techniques also result in the achievement of increased management effectiveness. For example they serve as tools for the following:

1. to evaluate feasibility and alternative designs and to establish technically realistic contract requirements;

2. to perform more effective trade-offs, system analysis, system effectiveness estimates and better Contract Definition;

3. to improve evaluation of configuration changes, value engineering, or cost-reduction changes;

4. to form a better basis for estimating force structures;

5. to permit to a greater degree the use of Life Cycle Costing as a basis for contract award; and

6. to plan better maintenance and integrated logistic support.

So you see that reliability and maintainability techniques with attendant quality assurance measures result in effective tools for management in many areas of operation.

While we have highlighted some of the more important techniques developed to specify, predict and measure reliability and maintainability, we must not forget the relationship of a critical area - Production and Maintenance. Workmanship defects can be a death knell denying the achievement of reliability and maintainability which is inherent in the design. Industry and Government must rely very heavily on the Quality Control/Quality Assurance functions to see that inherent high-reliability designs do in fact become high-reliability hardware and are maintained at these levels.

In conclusion I wish to compliment all of you who participated in this conference. I understand that high morale and interest have been evident and most impressive. Your conference objectives must have been achieved. Certainly there must have been a great deal gained from the interchange of information between participants from the Military Departments, Defense and other Government Agencies. I'm sure that a detailed study of your recommendations will result in improvement and innovation. Secretary Ignatius and I both wish to thank you for your efforts. We urge you to continue these efforts in this area so vital to our fighting forces. I know that you will; and that, throughout the world men who would otherwise die, will live as a direct result of your efforts.